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Japaness Steel Industry View from Overseas-3

The Japanese Steel Industry-Assessment and Particularities from a German Viewpoint

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The opportunities afforded by today's high-speed information exchange have greatly amplified our mutual interest in cultural, scientific and technological developments, whether in the West or in the East. This exchange has not, however, led to an equalization of conditions on a global scale, since events and developments are strongly dependent on local factors such as culture, education, training on the one hand and available raw materials, energy supply and market conditions on the other hand. This is also true for the steel industry, despite the fact that, at first sight, it certainly constitutes one of the most mature technological activities of industrialized societies anywhere. The present document addresses differences in crude steel making between the highly developed steel industries of Japan and Germany, and presents some existing assessments and expectations from economic and technical points of view.

1 Economic development

1.1 Comparison with overall economic trends

There is probably no other country in the world that has undergone such a fundamental economic change as Japan did in its period of peak economic growth (1953-1973). Within a mere 20 years' time, its economy progressed from that of predominantly agricultural society to a World Champion exporter of products such as cars and steel. Between the early '60s and mid 70's, the country's steel industry grew even faster than its rapidly expanding GDP. While the latter rose by a factor of 3.2 during this period, the country's output of crude steel was boosted to 5.4 times its baseline value.

The steel industry thus laid the industrial foundations for a modern industrial economy at a very early stage. Since then, technological activities have been focused chiefly on innovation and quality improvement.

Following the Asian crisis, since the start of the year 2000 we are now observing a recovery in industrial output. While the production of crude steel is already growing faster than last year, domestic demand is not keeping pace. The driving growth factor remains demand from abroad, which has increased by an impressive 80% since the end of 1998. In other words, this additional output is almost exclusively export-bound, with the need for steel being fuelled primarily by dynamic growth in neighboring countries.

Japan's crude steel production in the first half of 2000 corresponds to an annualized output of 104 million tons. As a result, capacity utilization rose clearly beyond previous years' level, to a fairly high 80% (vs. about 70% in 1998 and 1999, respective-

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ly). The expected full-year figure adds up to about 100 million tonnes once again.

Since the early '80s we have seen production capacity cuts by almost 16%, or 26 million tons of crude steel. If we compare this with the capacity trend in Germany, where crude steel capacities were slashed by about 30% (23.5 million tons) since the early '80s, it emerges that there may still be some scope for further capacity adjustments here.

It is generally believed that mergers or production range alignments are a necessary condition for further capacity downscaling. In their last business year, some manufacturers sustained losses as a result of high restructuring expenditures. Moreover, the additional shipments to neighboring markets consisted essentially of semi-finished products and hot wide strip with low profit margins. Nevertheless, the industry is likely to benefit from previous cost-cutting programs in the future. To meet competitive challenges and cope with the process of industrial change, shutdowns of unprofitable production facilities and a concentration on core fields of competence have been announced. In other words, the reorganization of the industry is already underway.

On the other hand, the highly dynamic export trend shows that Japan should not be underestimated as a competitor in times of slack domestic activity. While it is true that about three-quarters of all exports are shipped to neighboring countries, the U.S. response to major increases in Japanese delivery volumes illustrates the sensitivity of the market.

1.2 Comparison with Germany

A comparison between Japanese and German domestic and export prices reveals the different levels of competitiveness in the respective national markets.

In Japan, the domestic prices of virtually any product have been exceeding the export price during the last few years, chiefly as a result of low imports. With an import rate (percentage of supply coming from imports) of 7.3% (1999 average) and an export rate (percentage of production headed for export) of 30.5%, the steel industry is capable of maintaining domestic prices even when the overall domestic economy is weak. The high output growth characterizing the last six months, for instance, has not depressed domestic prices because it goes into export, again mainly into neighboring Asia.

In Germany the differences between domestic and export price levels are smaller and may be alternately negative or positive. This illustrates the amount of competitive pressure in the German and/or European marketplace. Domestic prices in Germany follow the international price trend, whereas in Japan they are less dependent on international market developments.

A comparison of the long vs. flat products ratio shows that the Japanese share of hot-rolled flats, accounting for 63% of the total hot-rolled output, is slightly lower than the corresponding German figure (67%).

The Japanese per-capita supply, at about 550kg of rolled steel, clearly exceeds the German per-capita level of 420kg (1999). What appears to be a very high per-capita supply for a highly developed industrial country can be explained with major government infrastructure investment involving high steel demand, and with the prominent role of the automotive industry and other steel-consuming manufacturing sectors.

2 Technical development

The Japanese steel industry is the world's most technically advanced today in terms of production processes and manufactured quality. Plant productivity has been selectively increased and a high degree of automation has been achieved to cut down on high labor cost. To a German observer, the picture today presents itself as follows:

2.1 Hot metal production and pre-treatment

Both in Germany and Japan, steelmakers rely predominantly on the blast furnace/converter route, which accounts for approx. 70% of total output in both countries.

Part of the preconditions behind the use of the blast furnace method lies in the production of coke. The Japanese coking plants are currently at an

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advanced average age of approx. 25 years. Instead of new building, operators have so far focused on what may sometimes appear as rather costly and sophisticated service life prolongation strategies. Given the plant energy demand situation, coke dry quenching systems are used with very few exceptions. Japan is a net exporter of coke. It is all the more remarkable that the country is undertaking development efforts aimed at innovative coke production techniques and cokeless liquid metal production processes (smelting reduction).

Since the Japanese steel industry goes back to the '60s, high-capacity sintering plants and blast furnaces incorporating the latest process engineering are already in place, whereas in Germany and other European countries, for instance, new and larger plants were slow to emerge in replacement of older, smaller ones. As far as plant operating regimes are concerned, key differences due to divergent energy cost structures and energy availability situations remain identifiable to this day.

The prevailing Japanese boundary conditions in the field of energy management have led to comprehensive measures to install heat recovery and gas generating systems at the metallurgical process stages. A comparison between Japanese and German sintering plants shows that Japanese manufacturers make more intense use of heat recovery technology while minimizing the consumption of ignition gas. On the other hand, blast furnaces usually produce gas, even to the point of compromising the consumption of reducing agents. The average consumption of reducing agents in Japanese blast furnaces, at 516kg per tonne of hot metal, is 50kg higher than that of its German counterpart. It is worth noting that, in order to economize on coke, all blast furnaces currently operating in Japan are now equipped for coal injection. The 1999 average coal input per tonne of liquid metal was approx. 130kg. In Germany the average amounts to 81kg per tonne of hot metal, while the average of all coal-injecting blast furnaces lies at about 150kg per tonne of liquid metal. The length of Japanese furnace campaigns likewise deserves to be emphasized: they exceed 20 years by now, whereas the maximum furnace campaign length in Germany still ranges between 10 to 13 years. Japanese blast furnace engineers view high specific productivity as detrimental to the furnace's service life. As a result, they tend to resort to increased furnace volumes if the daily furnace output is to be raised. To date, the only furnaces worldwide achieving annual outputs of more than 4.0 million tons of hot metal have been Oita 1 (14.7m hearth diameter) and Oita 2 (14.9m) operated by NSC in Japan, and Schwelgern 2 (14.9 m) at TKS*2 in Germany.

One characteristic feature of Japanese integrated steel mills is the pre-treatment of hot metal, in which the product is desulphurized, desiliconized and dephosphorized. This is due, on the one hand, to the increased phosphor loads associated with the use of Australian ore and the recycling of LD slag via the sintering plant, but also reflects the desire to minimize the concentration of trace elements in the steel. The low silicon content of the liquid metal permits only low converter scrap rates. On the other hand, this approach increases the converter output and reduces slag volumes by approx. 20%. On a global level this operating regime has not been able to prevail, if only because steelmakers in other countries use large scrap portions in the converter too, and because the number of requisite treatment vessels is clearly increased.

2.2 Steelmaking and continuous casting

Ever since the '80s, the advanced state of BOF steelmaking has found its expression in the use of combined blowing, dynamic process control systems relying on the use of sublances, and the OG*3 system for recuperation from the exhaust gas stream. This approach has set off many similar developments from which basic oxygen steelmaking in other countries has benefited.

The principle of using hot metal for converters and scrap for EAF has given rise to a slight export surplus of scrap in the last few years. However,

*2 Thyssen Krupp Steelの略
*3 転炉の非燃焼ガス回収法 Oxygen Converter Gas Recovery System

there appears to be still some scope for increasing the present converter scrap rates (approx. 6 %), given the crude steel trace element levels that can be tolerated and the precision achieved in adjusting the end-of-blow chemical composition of the crude steel.

Japanese EAF plants, too, attracted the attention of many European specialists as early as in the '70 s. Many of these experts came to learn about possible ways of increasing output and reducing the furnace's energy consumption. By now, energy inputs of lower than 300 kWh/t, oxygen inputs in excess of $25m^3/t$, liquid metal charging and tap-to-tap times below 60 minutes have become achievements of the past. The state of the art is so advanced that attempts at boosting output while reducing energy consumption have actually been reaching their limits in recent years, and the former "apprentices" from outside Japan have caught up with the technology. In Germany electric arc furnaces are operated with more than 40 heats per day.

Japanese "secondary refining" techniques have likewise made a pioneering contribution to the progress of steelmaking, specifically with the development of the RH process into RH-OB*4 and the introduction of the CAS-OB*5 method. In Japan, some 50% of all converter-produced crude steel is subjected to vacuum treatment today, while the corresponding rate in Germany is only about 35%.

The share of continuous casting has already reached 98% in Japan. In terms of plant technology, no expenses are spared to achieve the utmost in quality standards. The "armamentarium" employed today in all steelmaking plants to ensure maximum quality ranges from plasma-burner tundish heating systems to electromagnetic in-mould flow control technology, the separation of inclusions in the vertical section, and innovative "soft reduction" methods. The high productivity levels accomplished with continuous casting and hot-rolling have not left much chance for new near-net-shape casting developments, especially since the latter are not yet able to fulfil all the high quality demands imposed, e.g., by the automotive industry. Instead, steelmakers seek to meet the challenges of near-net-shape casting and casting-rolling techniques by implementing further increases in casting speed, a high input of hot charging into the rolling process, and "endless rolling" concepts. From a European point of view, these are very sophisticated and costly techniques.

3 Steelmaking and environmental protection

As early as in the '70s, European visitors to Japanese steelmaking plants noted the "green" plantings in outdoor mill areas and the obligatory fishponds fed with purified waste water from the plant. Even beyond the field of steelmaking technology, Japan was the pace-setter in emission control and pioneered the concept of harmony between man, work and environment, as well as the idea of a "sustainable steel development" - notions that the rest of the world would not embrace until later. Numerous individual Japanese developments for processing or recycling metallurgical process dust and sludge testify to the enormous effort that has gone into the preservation of raw materials and resources.

4 Conclusions

The Japanese steel industry is equipped to meet maximum quality demands on the part of its clientele. It clearly makes an effort that goes beyond the European approach of limiting steel treatment expenditure to the just necessary required for reliably achieving the specified material properties - unless the customer is willing to pay more. Even if capacity adjustments may become inevitable, Japan will emerge from them as a stronger force in the world market. Increased burdens will be met, as before, through additional productivity enhancements and cost reductions, e.g., via large scale automation and "no-man" operating concepts.

Japan's research expenditure, which continues to

*4 RH-Oxygen Blowingの略
*5 Composition Adjustment by Sealed Argon Bubblingの略

be very high in comparison with other countries despite a slight downtrend in recent years, testifies to a robust optimism with which the steel industry tackles the challenges of the future. It is derived from the conviction that steel remains the material of choice for a sustained development of society. Forward-looking projects are largely handled in joint enterprise. Such collective programs, e.g., the "Creation of Ultra-Steels for the 21st Century", constitute the Japanese answer to the "European challenge" perceived to be imposed by ECSC*6 steel research. In the Iron and Steel Institute of Japan (ISIJ), a resourceful organization with an open-minded, international approach is available to identify new trends and developments in steelmaking for the benefits of our material and to engage in international exchanges of the type practised since the '70s, e.g., in the "Japan-Germany Seminars on the Fundamentals of Iron and Steelmaking". Despite all differences identified, steelmakers in Germany and Japan share the common determination to provide the customer with the most suitable and eco-friendly steel money can buy. German and Japanese metallurgists can still learn a lot from each other, and the potential for further cooperation is huge. To one visitor of a Japanese high-performance BOF steelmaking plant, this link between East and West was brought home with particular clarity when he noted that the sliding doors on the converter platform closed with Ludwig van Beethoven's "For Elise" as a start-of-blowing signal.

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*6 European Coal & Steel Communityの略

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